Qimarox®

Functional description
Prorunner mk1

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1 About this manual

1.1 Introduction

This document attempts to provide as clear as possible an insight into the functionality, operation and components of the machine for designing the software function blocks for the OEM / system integrator.

1.2 Version history

Version	Author	Description
V1.1	GVI	First version in standard lay-out

1.3 Product documentation

Document	Reference
Machine manual[1]	UM Prorunner mk1 v4.1 EN
Electrical drawings[1]	Electrical drawings Prmk1 V6.6 EN

1.4 Source language

This manual was originally written in the English language.

[1] Generic information

1.5 Symbols used in the manual

The following symbols are used in this manual.

WARNING

Risk of serious injury to the user if the instructions are not accurately followed.

CAUTION

Risk of damage to the machine if the instructions are not accurately followed.

Note

To provide additional information to the user about a task or issue.

1.6 Terminology list

The table below explains common terms used in this manual.

Term	Definition
Machine	Prorunner mk1
Product conveyor	Conveyor that can be mounted on the carrier of a Prorunner mk2; for example a Qimarox RDC1 conveyor.
Upstream	Modules supplying the pallet conveyor with products (infeed sided).
Downstream	Modules that receive the products that are processed by the pallet conveyor (outfeed sided).

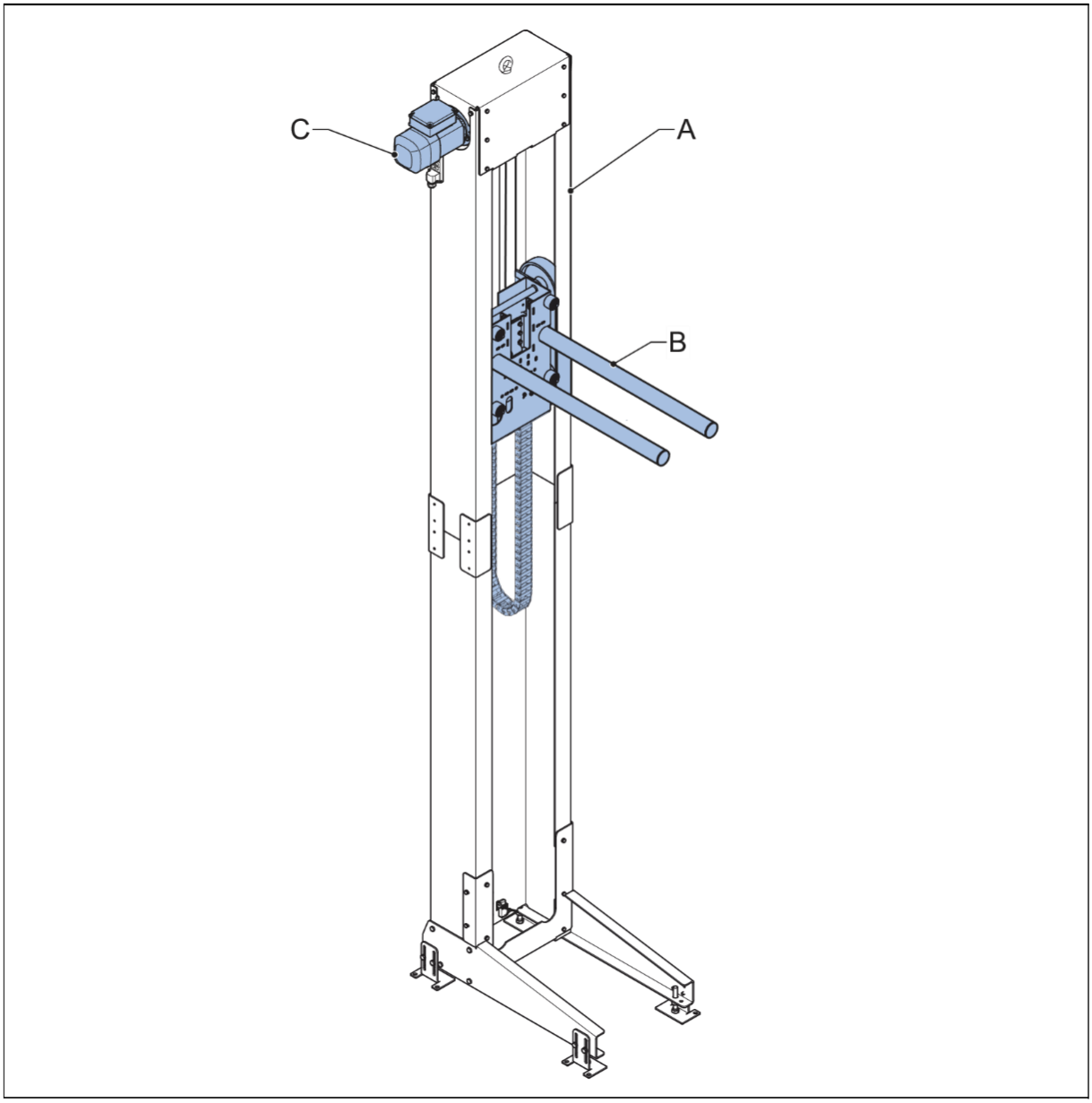
1.7 Further support and information

Qimarox can supply additional expertise and support services, for:

- Training
- Global support
- Service contracts

For more information please contact Qimarox.

2 Description

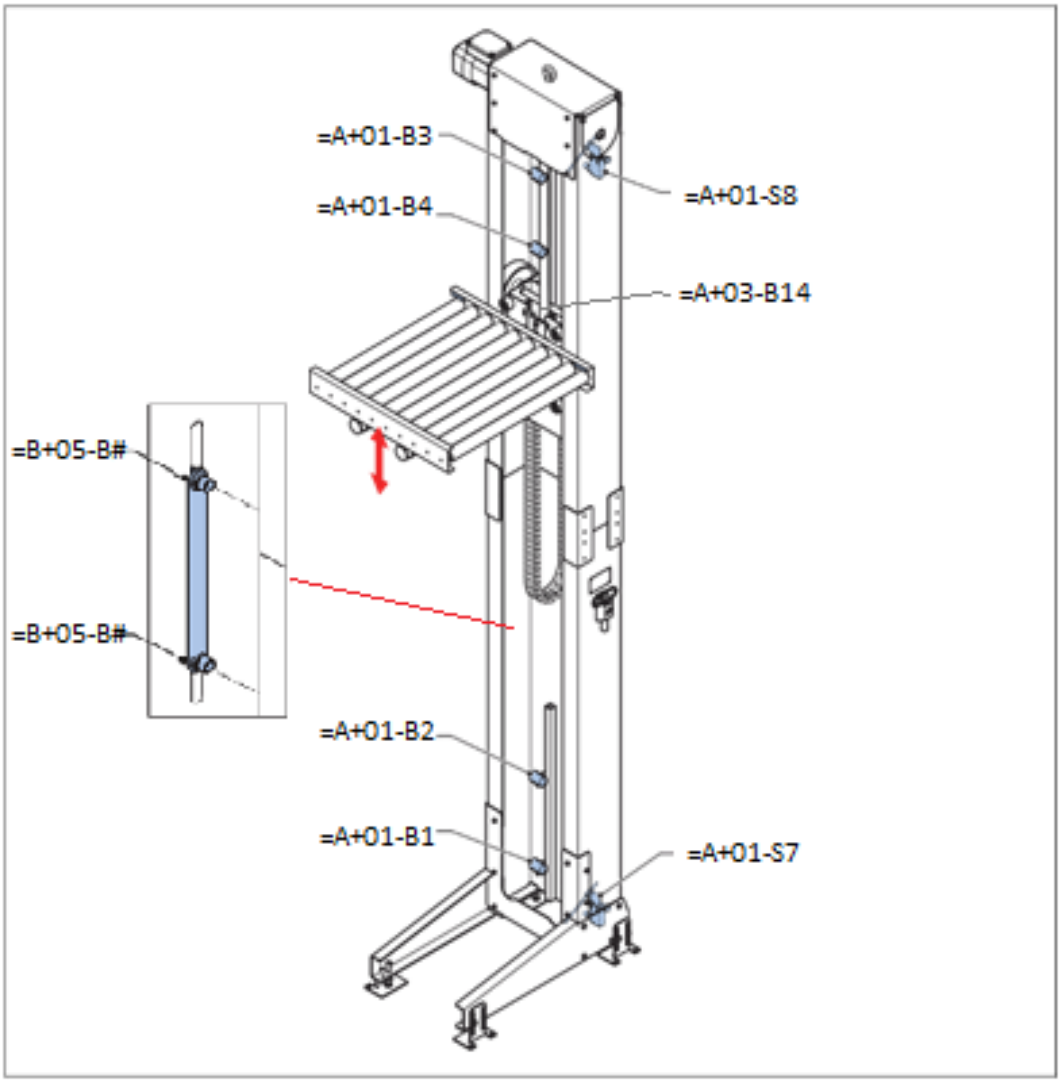


Figuur 1 - Overview of the machine

A. Column
B. Carrier
C. Drive

The machine is designed to vertically transport a product from one level to another consisting of a column, a moveable carrier and a motor. The carrier is suspended by a belt which is driven by the motor. The carrier moves through the column of the machine.

3 Operating principle



Figuur 2 – Electrical components overview

=A+01-B1	Bottom stop position
=A+01-B2	Bottom low speed position
=A+01-B3	Top stop position
=A+01-B4	Top low speed position
=B+05-B#	Additional level downward stop & upward low speed
=B+05-B#	Additional level upward stop & downward low speed
=A+03-B14	Belt tension detection (optional)
=A+01-S7	Bottom limit switch (optional)
=A+01-S8	Top limit switch (optional)

At each level two sensors are installed, by default =A+01-B1 and =A+01-B2 at bottom level and =A+01-B3 and =A+01-B4 at top level. When the carrier is moving and the low speed sensor is activated, the carrier's speed must be reduced to low speed. Once the stop sensor is activated, the carrier must stop.

When the machine is configured to stop at more than two levels, two sensors per extra level are installed in the column. When the carrier is moving and one sensor is activated, the carrier's speed must be reduced to low speed. Once both sensors are activated, the carrier must stop.

Because the vertical movement is a hoist application and to be able to switch between normal speed and low speed; the Prorunner has to be equipped with a inverter. Preferably with a bus system to enable dynamic control of velocity and ramp time. Please refer to chapter 9 for a graphical reproduction of the Prorunner movement.

3.1 Start-up procedure

To be able to run the Prorunner, the program must first return to basic position. This is done by moving the Prorunner to the bottom level. This movement to the bottom level needs to be monitored by the max movement time (Paragraph 3.8). Once arrived at basic position the Prorunner must communicate that it has arrived at basic position, and wait until the conveyor module has also finished the start-up check.

This start-up procedure must be started in the following situations:

- First start after switching on the machine;
- After every fault/alarm from the conveyor module;
- If the software loses the status position after manual movement.

3.2 Move to in- & outfeed level

Depending on if the carrier module has an object present or not; the Prorunner will move to its configured in- or outfeed level. This movement must be monitored by the maximum movement time (Paragraph 3.8).

The destination level is reached if both position sensors of the corresponding level are triggered. If only one position sensor is triggered the carrier must slow down to 0,03 m/s:

Example – 2 level configuration (movement down):

Current level:	Top level (2)
Destination level:	Bottom level (1)
=A+01-B2 Triggered :	Slow down carrier to 0,03 m/s
=A+01-B2 & =A+01-B1 Triggered :	Stop → Current level = bottom level (1)

Example – 5 level configuration (Movement down):

Current level:	Top level (5)
Destination level:	Third level (3)
=B+05-B4 Triggered :	Slow down carrier to 0,03 m/s
=B+05-B4 & =B+05-B3 Triggered :	Stop → Current level = third level (3)

Example – 5 level configuration (movement up):

Current level:	Bottom level (1)
Destination level:	Third level (3)
=B+05-B3 Triggered :	Slow down carrier to 0,03 m/s
=B+05-B3 & +Prmk9.ES-B4 Triggered :	Stop → Current level = third level (3)

Note
In normal operation the carrier's velocity will increase when moving up. This is because the belt rolls up on the pulley, resulting in an increasing pulley diameter. To compensate for this phenomenon the program should use different deceleration times per level. Next to this, the Prorunner should use a shorter deceleration when the carriers stops from low speed. This enables the Prorunner to position more exact. If the inverter is not equipped with a bus system, please adjust the deceleration time on base of the top level. This may decrease the capacity of the Prorunner.

Refer to chapter 9 for a detailed graphical overview of the velocity profile of the Prorunner.

3.3 Communicating in- / outfeed directions

After moving to an in- or outfeed position the Prorunner needs to communicate the in- or outfeed direction to the conveyor module. This could be done by means of an handshake or by running through a certain stepper.

3.4 Infeed

Once arrived at the infeed position, the Prorunner must wait until the conveyor module is ready to feed in a product. If all conditions are met the status of the Prorunner will communicate a starved signal upstream, and a product from upstream may now feed in.

Conditions for bringing out a ready to receive signal upstream:

- Prorunner is at the requested infeed level;
- Conveyor module is ready to feed in an product;
- Positioning is locked (Paragraph 3.6).

The Prorunner must wait at the infeed position until the handshake or the active stepper of the conveyor communicates that an object is present. During this whole process the Prorunner must lock the position to keep the carrier levelled. (Paragraph 3.6)

3.5 Outfeed

Once arrived at the outfeed position the Prorunner will wait at the outfeed level. If all conditions are met, the Prorunner can give the conveyor module a signal to start feeding out the product.

Conditions for starting the outfeed process:

- Prorunner is at outfeed level;
- Downstream conveyor is ready to receive an object;
- Positioning is locked (Paragraph 3.6);

The Prorunner will wait at the outfeed position until the conveyor module has finished feeding out the product. During this whole process the Prorunner must lock the position to keep the carrier levelled. (Paragraph 3.6)

3.6 Positioning locked

Due to the roll up and stretching of the belt, combined with the shifting weight when feeding a product in/out, the program must lock the position. If one of the sensors are not triggered anymore (carrier shifted up or down) the program has to compensate for this by moving the lift slightly up or down at low velocity (0,03 m/s):

Example 1 – feeding in product, carrier jumps slightly down due to the extra weight:

Current level:	Bottom level (locked)
=A+01-B1:	**TRUE**
=A+01-B2:	TRUE → **FALSE**
Lift.Forward:	FALSE → **TRUE**
Lift.Reverse:	FALSE

Example 2 – feeding out product, carrier jumps slightly up due to the loss of weight:

Current level:	Bottom level (locked)
=A+01-B1:	TRUE → **FALSE**
=A+01-B2:	**TRUE**
Lift.Forward:	FALSE
Lift.Reverse:	FALSE → **TRUE**

CAUTION
This re-locking process must be monitored by a timer. If this timer has reached the preset value of ~3 seconds it has to generate a fault and stop the machine.

3.7 First-in-first-out

When the configuration consists of more than two positions (Positioning), the Prorunner needs to know to which infeed level it has to move. To do this the Prorunner must handle the products that come available on the third-party supply conveyors in a “first-in-first-out” way.

The program on the upstream conveyor needs to communicate a source and destination level with the product available on each third-party supply conveyor. The program of the Prorunner should continuously scan all levels for products, and store this data first-in-first-out and move to the first available product.

The following data has to be available from the conveyor upstream that has an product ready on a third-party supply conveyor for the Prorunner to pick-up:

- Product ready for pick up on the upstream third-party supply conveyor;
- Source level of product;
- Destination level of product.

When the Prorunner has fed out the product; the data containing the product information (source / destination level) must be erased from the first FIFO spot. All of the next filled FIFO spots must be shifted towards this first emptied spot. If no product is detected during the start-up check, the first spot will also be erased (Paragraph 3.1). If the FIFO registry is empty, the Prorunner should wait at the last destination level or move to a infeed level depending on the configuration.

3.8 Max movement time of carrier

All movement of the carrier of the Prorunner must be monitored by a timer which contains the max movement time (the total time it takes to move the carrier from bottom to top position) as a preset value. If the maximum movement time is exceeded during this step, an alarm will be generated and the machine must stop.

$$Maximum\ movement\ time[ms] = Total\ Movement\ time \times Margin$$

Note

Please make use of an retentive timer.

3.9 Unknown positioning status level

If the program loses its status level entirely after an fault or manual movement in automatic mode, the Prorunner must perform a start-up check again.

Example 1 – Manual movement has lowered the carrier to unknown position:

Current level:	Top level (2)
=A+01-B3:	**FALSE**
=A+01-B4:	**FALSE**
Lift.Forward:	FALSE
Lift.Reverse:	FALSE
Startup.Required:	FALSE → **TRUE**

Example 2 – Manual movement has slightly lowered carrier and tries to re-lock the position:

Current level:	Top level (2)
=A+01-B3:	**TRUE**
=A+01-B4:	**FALSE**
Lift.Forward:	FALSE → **TRUE**
Lift.Reverse:	FALSE
Startup.Required:	FALSE

3.10 Overshoot detection (Verify level lock)

After reaching the target position, the software must be able to detect overshooting of the carrier and verify the level lock. If the Prorunner loses its locked position during this time, the carrier has passed the slow down sensor and a fault will be generated. This can happen due to deceleration times that are too high.

Example 1 – Carrier has reached level 1 and the status level is updated (Normal operation):

Status level:	Top level (2) → **bottom level (1)**
Command level:	Bottom level (1)
Lift.Reverse:	TRUE → **FALSE**
Lift.Running:	**FALSE**
=A+01-B2:	**TRUE**
=A+01-B1:	**TRUE**

Example 2 – Carrier has reached level 1 and the status level is updated but the carrier overshoots its position (Fault):

Status level:	Top level (2) → **bottom level (1)**
Command level:	Bottom level (1)
Lift.Reverse:	TRUE → **FALSE**
Lift.Running:	**TRUE**
=A+01-B2:	**TRUE → FALSE**
=A+01-B1:	**TRUE**

3.11 Creep detection

During normal operation the software should be able to monitor the total time it takes to crawl at low velocity (0,03 m/s) to the stop position. If this crawl time is higher than three seconds, the program will create a warning that the deceleration time can be increased to improve capacity. Normal operation during this warning continues.

3.12 Passed destination detection

During automatic mode the program must try to detect situations when the carrier passes the destination level due to a faulty sensor for example. This is done by monitoring the expected triggering of positioning sensors.

Example 1 – Carrier has reached bottom level and the status level is updated. (Normal operation)

Status level:	Top level (2) → **bottom level (1)**
Command level:	Bottom level (1)
Lift.Reverse:	TRUE → FALSE
=A+01-B2:	**TRUE**
=A+01-B1:	**TRUE**

Example 2 – Carrier has passed bottom level without updating the status level. (Fault)

Status level:	**Top level (2)**
Command level:	Bottom level (1)
Lift.Reverse:	TRUE
=A+01-B2:	**FALSE**
=A+01-B1:	**TRUE**

3.13 Reversal detection

In specific situations and when the Prorunner is not equipped with belt tension detection or end switches, there is a possibility that the carrier gets stuck and the belt will roll-up in the opposite direction. In this situation the carrier will now move in the opposite direction.

To prevent this phenomenon the software needs to detect this by using expected logic on the positioning sensors:

Example 1 – Carrier re-triggers the stop sensor while moving in reverse (2 level setup):

Status level:	Top level (2)
Command level:	Bottom level (1)
Lift.Reverse:	**TRUE**
=A+01-B3:	FALSE → **TRUE**
=A+01-B4:	**TRUE**

Example 1 – Carrier triggers unexpected sensor while moving in reverse (4 level setup):

Status level:	Third level (3)
Command level:	Bottom level (1)
Lift.Reverse:	**TRUE**
=A+01-B3:	**FALSE**
=A+01-B4:	FALSE → **TRUE**

3.14 End switches

The Prorunner can be optionally equipped with mechanical end switches (=A+01-S7 & =A+01-S8). These can be used to detect if the carrier has reached the highest or lowest position possible. If the end switch is triggered, the motor should be directly stopped.

During all Prorunner movement the program must monitor these enabled sensors and block movement if triggered This means that in no matter of what direction the Prorunner runs, the bottom end switch and top end switch must trigger a fault..

Note
Manual mode can be used for recovery purposes (Paragraph 3.16).

CAUTION
To prevent extensive damage to the machine, automatic mode may not be started when the end switches are not returning a signal.

3.15 Belt tension detection

The Prorunner can be optionally equipped with a belt tension detection sensor (=A+03-B14). This sensor detects if the belt is still tensioned and the carrier is not blocked during movement downwards. If the carrier reaches the mechanically lowest possible position, or is blocked by an object; the belt will not be tensioned anymore and the belt tension detection sensor will be triggered. If the belt tension sensor is triggered the motor should be directly stopped.

During automatic mode the software must monitor the status of this belt tension detection. If the sensor loses the signal, a fault must be generated and automatic must be stopped to prevent damage.

Note
Manual mode can be used for recovery purposes (Paragraph 3.16).

CAUTION
To prevent extensive damage to the machine, automatic mode may not be started when this safety mechanism is not returning a signal.

3.16 Manual operation

The Prorunner may be moved forward and reverse by hand. During this manual operation the function of the optionally equipped belt tension sensors and end switches are active. When moving forward or reversed the bottom and top position sensors must not be occupied:

- *When moving forward, the sensors =A+01-B4 and =A+01-B3 must not be occupied;*
- *When moving reverse, the sensors =A+01-B1 and =A+01-B2 must not be occupied.*

If the Prorunner is equipped with end switches or belt tension detection the Prorunner will only move in the opposite direction. Movement towards the triggered sensor is blocked:

- *When moving forward, =A+01-S8 (end switch top) may not be triggered;*
  When moving reverse, =A+01-S7 (end switch bottom) and =A+03-B14 (Belt tension detection) may not be triggered.

Note
During manual operation, the machine should use slower velocity settings.

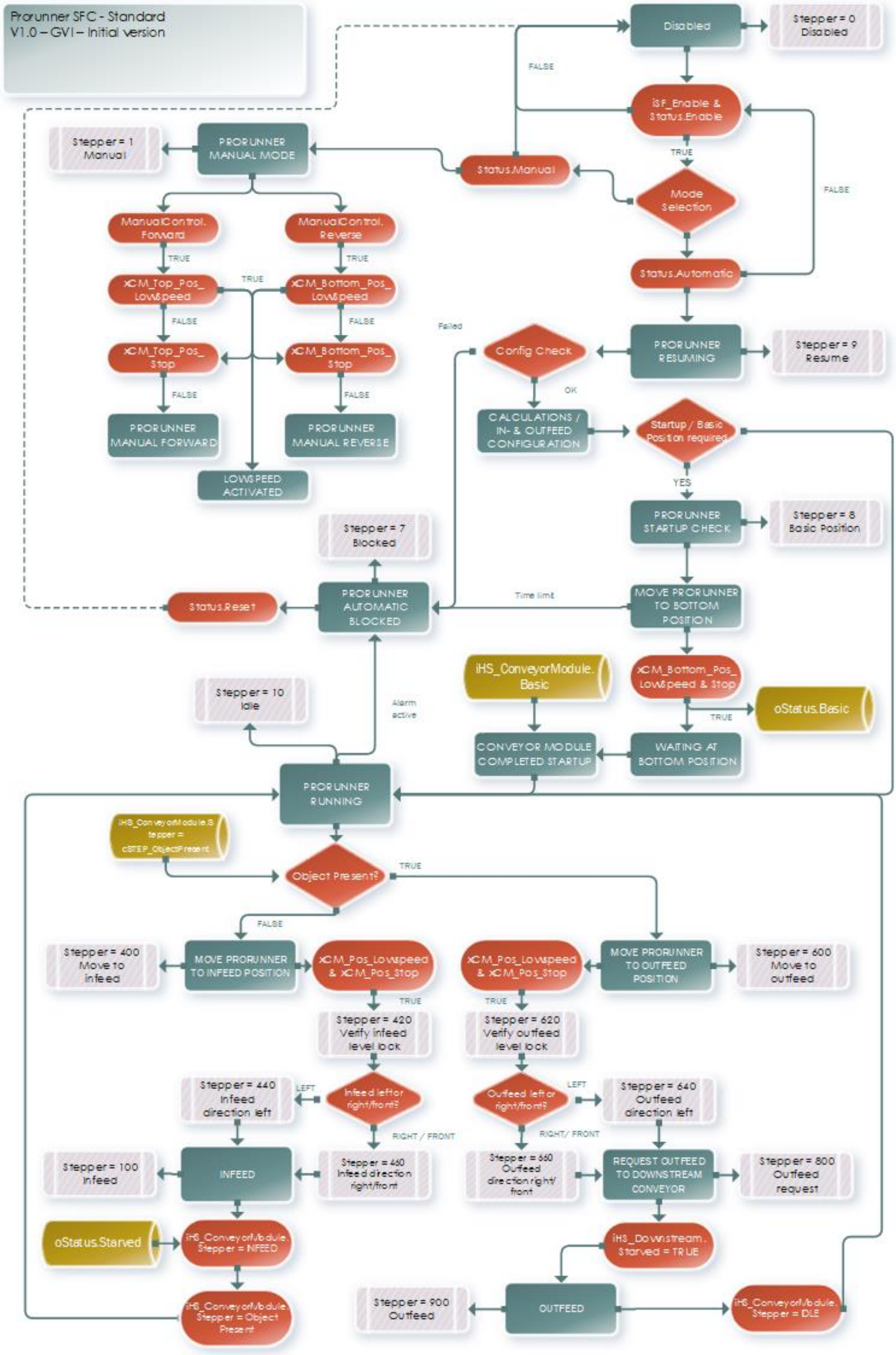
3.17 Faults

In case of a fault/alarm, the software function block should return an specific fault code to inform the operator. Below is the list of faults that can be active with explanation/effect and solution. Certain faults are only possible after selecting/activating certain options. Malfunctions will block or stop automatic operation in all cases. If all reset conditions are met and the user gives the reset command, the fault will disappear. The latter does not apply to faults that can solve themselves.

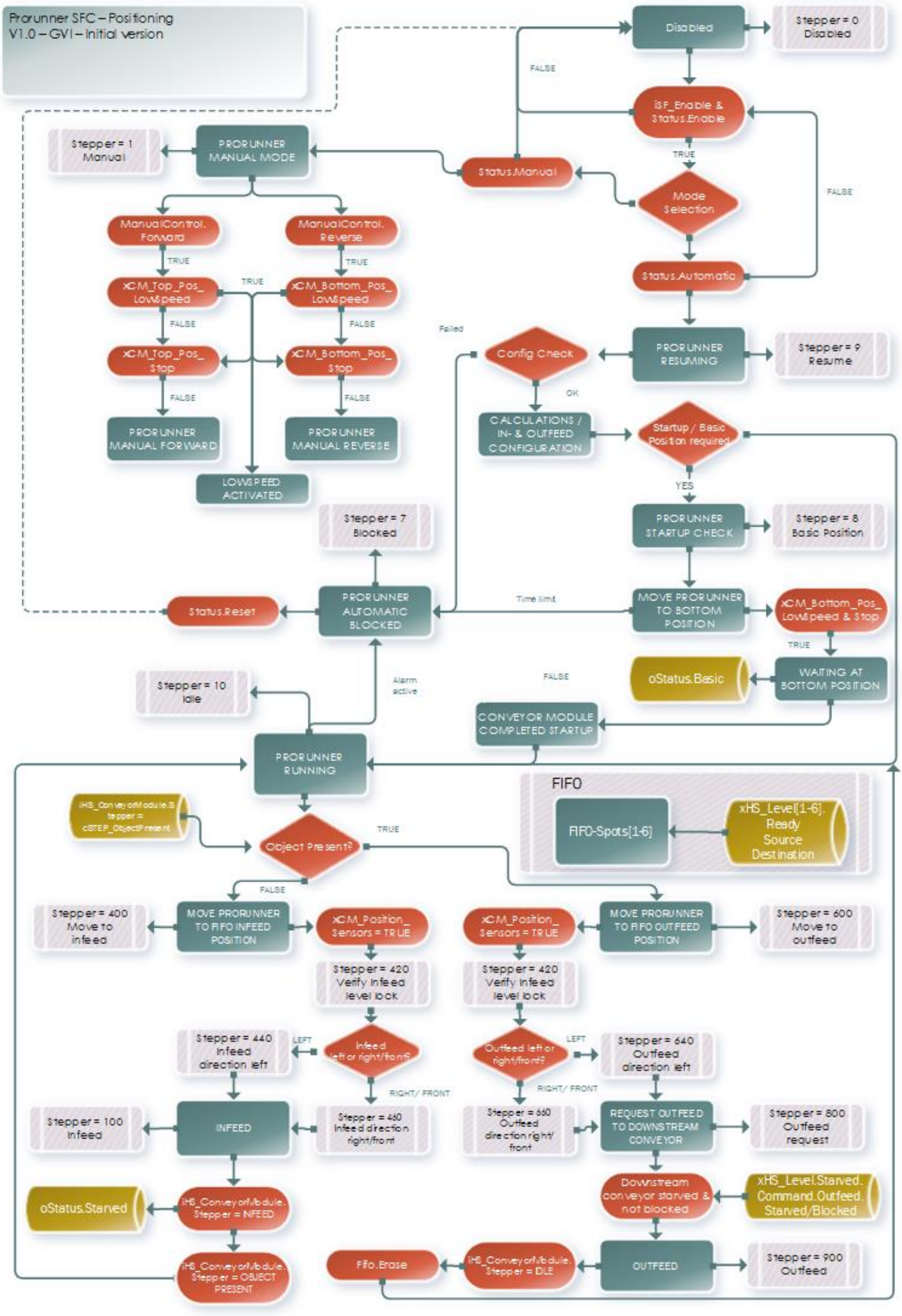
Bit	Description / Cause	Effect	Solution
1	Unknown/illegal destination. Prorunner destination level is incorrect, and the vertical conveyor doesn't know to which level to move to.	Automatic operation is stopped. Prorunner is on hold (Controlled stop)	Check the level configuration. If configured with more than 2 levels check the handshake information gathered from the infeed level. Give the reset command to reset the fault.
2	Movement to infeed level takes too long.	Automatic operation is stopped. Prorunner is quickly stopped (Quickstop)	Check Prorunner for blockages. If Prorunner is operating for the first time check the configuration. Give the reset command to reset the fault.
3	Movement to outfeed level takes too long.	Automatic operation is stopped. Prorunner is quickly stopped (Quickstop)	Check Prorunner for blockages. If Prorunner is operating for the first time check the configuration. Give the reset command to reset the fault.
4	Movement of Prorunner is blocked. Inverter returns a fault code	Automatic operation is stopped. Prorunner is quickly stopped (Quickstop)	Check Prorunner for blockages. Give the reset command to reset the fault.
5	Carrier has passed the top or bottom level and triggered the limit switch.	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Check if the sensors =A+01-B1, -B2, -B3 and -B4 are working correctly and check the deceleration time. Manually move the carrier up/down and give the reset command to reset the fault.
6	Reversed movement detected due to the inverted rolling-up of the belt	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Please refer to paragraph 6.12.
7	Belt tension sensor is triggered.	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Check Prorunner for blockages; if no obstructions are detected, check sensor =A+03-B14. Give the reset command to reset the fault.
8	Carrier has passed the destination level.	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Check the concerning positioning sensors and alignment. Give the reset command to reset the fault.
9	Time-out while trying to lock the position.	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Check the concerning positioning sensors and alignment. Give the reset command to reset the fault.
10	Overshoot detected while positioning.	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Check deceleration time of the concerning level. Give the reset command to reset the fault.
11	Unknown positioning status level.	Automatic operation is not possible. Prorunner is quickly stopped (Quickstop)	Give the reset command to reset the fault. Start-up check will be activated and the Prorunner will move to its bottom position.
12	Crawl time-out detected while positioning.	No action	Deceleration time of concerning level can be increased to improve capacity.

Tabel 1 – Machine fault list

4 Appendix A - Sequential function chart - Standard



5 Appendix B – Sequential function chart - Positoning



6 Appendix C – Prorunner velocity profile